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Gender, information and the efficiency of household production decisions: An experiment in rural Togo

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Communication and production in the family farm: Theory and evidence from rural Togo. *

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We test the existence of cheap talk between husbands and wives working together in a family business. Our setting is the farm household. We designed an experiment, contextualized as an input allocation game, in which the husband chooses the amount of resources to invest on his own plot and on his wife's land. The return from the land managed by the wife is higher. We experimentally vary whether the returns from the wife's plot are communicated to the husband (i) by the experimenter, (ii) by the wife herself, and (iii) by the wife herself but with the possibility for the husband to verify the accuracy of the information from the experimenter after he makes his allocation decision. Male producers allocate too few inputs to their wife's plot across all experimental conditions. We rationalize these findings in a setting with limited enforcement of marital agreements and derive additional predictions. First, allocative inefficiencies in production are worse when women hold private information compared to the full information treatment. This effect is stronger for households for which resource-sharing under full information is lower. Second, communication between spouses can only compensate for damages from private information when the information is verifiable ex post.

JEL Codes: Q12, C72, D13, D82, C91, C93.

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1 Introduction

Husbands do not listen to wives, as recent studies on intra-household communication have found (Conlon et al., 2022; Ashraf et al., 2022). And yet, intra-household communication is key to avoid intra-household inefficiencies, especially in contexts in which spouses manage separate but interconnected activities. In rural Africa, small-scale farms are typically family-run businesses, and members of the household quite often farm separate plots (Guirkinger and Platteau, 2015). They are repeatedly found to make inefficient allocations of productive resources across plots.[1] In most cases, within-household misallocation is gendered, with too few inputs used on female-managed plots (Doss, 2018). However, little is known about the causes of these inefficiencies, especially in relation to communication failures between spouses.

To fill this gap, we investigate the farm household's capacity to share information on production-related activities, thereby overcoming information asymmetries. To do so, we designed a laboratory-in-the-field experiment. Our experiment is structured as a standard game of resource-sharing within the household (Munro, 2018), with an added information component. We tested: (i) whether spouses are able to transmit information on returns from different plots; (ii) whether failure to communicate is linked to conflict of preferences (cheap talk); (iii) which households are particularly affected by communication failures.

We study the agricultural production decisions of Togolese cotton producer couples living in marital relationships in a laboratory-in-the-field setting that allowed us to experimentally vary the content of the information for the decision maker.[2] Each couple played a series of two games. In both rounds, the spouses could communicate prior to the decision, which was made privately by the husband. We asked each husband to decide whether to invest in his own plot of land with low returns or in his wife's land with high returns but where the payoff would be to her rather than to him. Incentives were set such that any deviation from allocating all of the endowment to the wife's land implied a loss of efficiency to the household.

In the first round, where decisions are made under full information, we find that male farmers allocate too few inputs to their wife's plot. As expected, some households failed to maximize household aggregate profits. We observe average efficiency losses of 17.8 percent despite information being complete. In the second round, we experimentally manipulated the information available to husbands. We randomly assigned couples to one of three treatments: (1) *full information*, as in the base game, (2) *hidden information*, in which

[1] Following Udry (1996)'s seminal article, further evidence of allocative inefficiencies in agriculture includes Akresh (2008) for Burkina Faso; Andrews, Golan and Lay (2015) for Uganda; and Guirkinger, Platteau and Goetghebuer (2015) for Mali.

[2] Tests of allocative efficiency in production using observational data may suffer from measurement error and unobserved heterogeneity at the plot level (Rangel and Thomas, 2019).

women are offered the opportunity to hide the true return from their husbands, (3) *verifiable information*, in which, while women can hide the true return from their husbands, the information is verifiable ex post.

To sharpen our predictions on the role of private information and communication failure in allocative inefficiencies, we propose a framework that matches the structure of the experiment and builds on existing models of intra-household production and consumption choices. Our testing strategy highlights two sources of inefficiencies. The first reflects limited enforcement of resource sharing agreements and conflicting interests in consumption. The second results from information asymmetries on production from plots managed by a male farmer and those managed by his spouse.

We make two predictions that are testable with our experimental data. First, spouses are unable to communicate effectively, leading to additional inefficiencies beyond those due to conflicting interests over consumption. Information verifiability is a key assumption underlying cheap talk models. We test whether the lack of verifiability can explain the extra losses from private information despite the opportunity for communication. To do so, we compare the choices made under the *verifiable* and *full* information treatment. Husbands with limited enforcement ability should no longer be affected by information friction when information can be verified ex post. Second, the loss in efficiency due to information asymmetries on production reinforces the loss due to consumption choices: it is expected to increase as baseline inefficiency under full information increase.

Our findings are in line with the predictions that we have set up to test. Comparing the choices made under the *hidden* and *full* information treatments, we find that the effects of asymmetric information are negative and heterogeneous across households, according to the transfers made in the first round. The impact of private information decreases with first-round transfers. Furthermore, when we compare the choices made under the *verifiable* and *full* information treatments, there are no significant differences between the groups on average and no differences from the transfers made in the first round. Information frictions affect the efficiency of decisions only when information is "cheap" (that is, it cannot directly influence the decision-making process since it is not verifiable).

Our research builds on four strands of the literature. In the standard farm household model, households work as an economic unit making production and consumption decisions (Singh, Squire and Strauss, 1986). When markets fail, these decisions are no longer separable (LaFave and Thomas, 2016), and production can no longer be treated as independent of the preferences of household members. As such, the standard model predicts inefficient allocation of resources between households but efficient allocation within the household. In contrast, our focus is on the misallocation of productive resources within the home.

Within the literature on household decision making, our work is closest to the experimental work that studies the efficiency of spouse interactions, as well as the mechanisms underlying the decisions (Afzal et al., 2022; Almas et al., 2018; Iversen et al., 2011; Jakiela and Ozier, 2015; Hoel, 2015). Furthermore, we framed the experiment as an input allocation game to mimic the input allocation decisions of households engaged in agricultural production, thereby endogenizing spouses' incomes generated from female- and male-managed plots. As such, our work complements the analysis of input allocations in households and teams carried out by Bakhtiar et al. (2022) and Fafchamps and Kebede (2022). We add to this literature the investigation of allocation inefficiencies linked to communication failure. Moreover, in our work, the extent of allocative inefficiency in production is heterogeneous between households, in agreement with existing evidence (Angelucci and Garlick, 2016; Kazianga and Wahhaj, 2017; Hoel et al., 2017).

Our analysis extends to a setting in which some information is held privately. Thus, we contribute to the literature studying information frictions within the home (Anderson and Baland, 2002; Ashraf, 2009; Mani, 2011; Castilla and Walker, 2013; Chen, 2013; Chen and Collins, 2014; Hoel, 2015; Merfeld, 2019) by offering new insights into communication failure. In particular, while the existing evidence spans across spouses' different domains of action and points to heterogeneity in response to private information, it fails to link those to barriers to information transmission in the household. Fafchamps (2001) shows that information asymmetries reduce the ability of spouses to enforce marital agreements. We link enforcement issues under full information to the ability of spouses to communicate.

Our main contribution is to a small and emerging literature on the role of communication within the household.[3] Ashraf et al. (2022), in a large-scale randomized controlled trial, show the existence of barriers to communication linked to conflict over fertility preferences in the household. Cheap talk issues over fertility risk imply suboptimal fertility outcomes. Based on a controlled laboratory experiment, Conlon et al. (2022) show that women cannot transmit information to men in a context in which there is no conflict of interest between spouses. In relation to this literature, our main contribution is to propose the first lab-in-the-field experiment testing the importance of verifiability of information in cheap talk situations in the household and its impact on resource sharing. Our results confirm that women have trouble transmitting information to their husbands regardless of whether this is related to cheap talk issues. However, communication is much worse when the information is not verifiable, which implies that cheap talk plays an major role in communication failures.

The remainder of the paper is structured as follows. In the next section, we present the experiment and data. In Section 3, we lay out a testing strategy grounded in our proposed theoretical framework, as well as our empirical models. In Section 4, we bring

[3]Ziparo (2020) studies theoretically cheap talk on income realizations between husband and wife.

the additional predictions to the data. We conclude in Section 5.

2 Experiment and data

The objective of this section is to describe the experimental setting, the experimental protocol, and the data. The experiment is designed as a couple's investment game. There are two separate accounts from which each spouse can earn payoffs. We expect investments to depend on three factors: the returns on investment in each account, the extent of information held on these returns, and the extent to which spouses can communicate effectively (e.g. Ashraf, 2009; Kebede et al., 2014; Hoel, 2015). The experiment is contextualized to reproduce familiar production allocation decisions between plots managed by men and women farmers in the same household.

2.1 Experimental setting

The experiment was carried out in Togo, in the Plateaux region. According to the most recent national census, 97 percent of the population in Togo is employed in agriculture, 51 percent of agricultural producers are female, and 82 percent of them live in households headed by a man (National Agricultural Census 2012-2014). The Plateaux region is the primary cash crop production area of the country, producing mainly cotton along with coffee and cacao.

Participants were recruited with the help of Nouvelle Societe Cotonnaise du Togo (NSCT), responsible for organizing the cotton industry. Our sample was drawn from the latest cotton producer census conducted in the region by NSCT (2016), which identified 15,515 cotton producers, 1,081 of them women. We restricted the population to couples whose members are involved in cotton production and are aged 18 and over. After excluding polygamous households and couples residing in the remotest areas, we draw a representative sample of 150 couples out of the total population of 359 couples. After verifying marital status, the final sample size was reduced to 141 couples.

The experiment was carried out in NSCT facilities and in school buildings located in five central locations across the region during the month of October 2016. At each site, we invited participants from several surrounding villages. Each experimental session, followed by the collection of survey data, lasted two hours. We interviewed all participants in a given geographical area on the same day. Ten field enumerators trained by the experimenter (supervised by one of the authors) worked in pairs.[4] Protocols were provided in both French and Ewe and field workers were also fluent in the other local languages (Ife, Moba, Lamba, Kotokoli and Kabye).

[4] Field enumerator training on conducting the experiment took a total of two weeks.

When the participants arrived, the husbands and wives were separated. They were given a show-up fee and then invited to participate in the experiment. The choices made during the experiment are our main outcomes of interest and were recorded. Immediately after completion of the experiment, a survey was administered separately to husbands and wives. After a short debriefing on the game, the survey included questions on demographics, assets, education, literacy/counting tests, occupations, social preferences, and risk aversion. We also inquired about information-sharing within the couple, who decides how to exploit the individual's main plot, and who is responsible for the main goods produced by the households and their main expenditures. Both male and female respondents also reported their individual share of the broad categories of expenses.

We decided to focus on monogamous households, as only 17% of men aged 20-49 years in Togo are polygamous (20 percent in the Plateaux region).[5] Our findings are thus representative of decision-making outcomes for 80 percent of men and women living as a couple and producing cotton in the Plateaux region.

2.2 Experimental protocol

After receiving a show-up fee, participants were told they had the opportunity to earn more depending on the decisions made in the game. The game consisted of two rounds played sequentially. All participants were subjected to the same treatment in the first round. In the second round, spouses were assigned different treatments. The investment game was contextualized as an input allocation game to place the subjects in a familiar decision-making situation.

In all treatments of the game, the men made the decisions. Their wives were present during most of the game, were informed of the strategy set and payoffs, and could talk to their husbands prior to the decision. The men were told to decide how many of a total of 10 tokens (input units) to allocate to two boxes of different colors representing plots generating income for either husband or wife. Each male participant had to decide whether to invest in his own plot of land with low returns or in his wife's land with high returns but a payoff paid to her and not him. In all treatments, there was only one action that would maximize the household payoff: to allocate all inputs to the wife's plot.

Treatments

Baseline game The baseline game took place during the first round according to rules common to all participants. Importantly, in the baseline game, all the information was available to both the husbands and the wives. Choices made during round 1 enable us to estimate the extent of efficiency losses under full information about returns.

[5] These statistics are computed using DHS 2010 data.

We chose to have constant returns to scale production functions to make it easier for farmers to compute payoffs from their decisions. Returns on women's plots were twice as high as on men's plots. The payoffs were as follows:

$$\textbf{Female Payoff} = 2t,$$
$$\textbf{Male Payoff} = 10 - t,$$

where t is the number of tokens allocated to the wife's plot. Each token had a value of 100 FCFA (about US \$0.17). The maximum household surplus in the first round of the game was 2,000 FCFA, that is, US \$3.42 at the current exchange rate. In this round, the efficiency loss, expressed as the ratio of the surplus discarded to the maximum potential household earnings, is as follows:

$$\textbf{Efficiency Loss} = 1 - \tfrac{10+t}{20}.$$

Hence, for each token that a husband did not invest in his wife's plot, the household incurred a monetary loss of 100 FCFA.

Second round In the second round of the game, we *(i)* increased the returns on the wife's plot and *(ii)* introduced information asymmetries. The ratio of returns increased from two to three. Second-round payoffs were thus as follows:

$$\textbf{Female Payoff} = 3t,$$
$$\textbf{Male Payoff} = 10 - t,$$

where, again, t is the number of tokens allocated to the wife's plot. The maximum household surplus in PT was 3,000 FCFA, that is, US \$5.14 at the current exchange rate. Thus, the efficiency loss in the second round is as follows:

$$\textbf{Efficiency Loss} = 1 - \tfrac{10+2t}{30}.$$

The marginal loss was higher in the second round than in the first round of the game. For each token that husbands did not invest in the more productive female controlled plot, the household forwent 200 FCFA.

In this second round, in addition to increasing returns from women's plots, we also randomly assigned couples to one of three treatments:

1. a *full* information treatment in which the experimenter provided all the information on the returns (ET, for experimenter treatment);
2. a *hidden* information treatment in which the experimenter informed only the wife of the value of the return from her plot, while husbands received the information from their wives (HT, for hidden treatment);

3. a *verifiable* information treatment in which husbands received the information from their wives but both knew that the experimenter would reveal the true returns after the decision was made (VT, for verifiable treatment).

Payoffs under ET were similar to those in the first-round setting, but with returns on investment in the wife's plot amounting to three times as high as on the husband's plot. Condition HT was very close in design to ET, except that women could strategically manipulate the information on returns from their plots. In ET, the experimenter was in charge of communicating this piece of information. In HT, the wife was in charge of communicating it. Condition VT was very close in design to HT, except that the information was asymmetric before decision-making, although verifiable ex post. Note that in the information treatments (HT and VT), the experimenter told both spouses that the returns from female plots were at least as large as in the baseline game. Appendix B provides a thorough description of the protocol.

Communication

Once they had received all the instructions and had shown that they understood them, husbands and wives were instructed to talk to each other for five minutes before men made their decisions privately. The same instruction process was applied to both rounds and under all treatment conditions. Since wives communicate the returns of their plots in the HT and VT treatments, we included communication in the baseline game and in the ET condition as well, to ensure comparability. It is often argued that the opportunity to communicate in itself enables spouses to make Pareto-efficient choices. Moreover, in the real world, while women know more about the returns of their own plots, spouses actually have the opportunity to talk to each other. In addition, in our setting in which women do not choose the quantity of input to use on their plots on their own, being able to share the information on returns with their husband could be beneficial to everyone. In the experiment, we thus allowed time for pre-play communication between spouses in all treatments, without monitoring their discussions.

The issue of couples' lab behavior

Because participants in our experiment live in a marital relationship, we faced three key challenges. First, the behavior observed in the lab might have been undone once the spouses left the lab but continued to interact, making the experiment less informative. To obtain more reliable information, we gave players the opportunity to hide their rewards. We used two means: private payments to players and a system of lotteries that made it possible to conceal the exact value of payments received by male participants. In fact, although payments were made privately, the women could have guessed the decision simply from the amount paid directly to them. To avoid this, both the husband and the wife knew that their earnings would be partly determined by a series of two lotteries. The outcome of the first lottery determined whether they were remunerated on the basis of decisions made in the first or in the second round.[6] The second lottery introduced a state of the world in which they could earn zero. However, expected earnings in each round would be equal to the payoffs without the lottery.[7] Both spouses knew the basic structure of the lotteries, but wives could not observe their outcomes. As a result, wives were not able to infer, from their gains, their husband's decision and payoff. In the debriefing, most women (53 percent) declared that they did not know how much their husband earned in the lab; only 26 percent felt they could confidently predict the men's earnings.

Second, in the full information and verifiable treatments, as well as during the first round of the game, the men were fully aware of how much their wives earned. They could have decided to transfer all the tokens to their wives, knowing that they could recover them outside the lab through cash or inkind transfers. The debrief data, self-declared after playing the games but before leaving the lab, provided us with some evidence that individuals did not expect to obtain direct monetary transfers from their spouse as a result of their participation in the experiment (only two individuals of each gender declared that they expected direct transfers, less than 2 percent of the sample).

One final concern specifically concerns the hidden information treatment. Despite the privately-made payments, wives might not have been able to hide their payoffs after leaving the lab. Husbands might have forced them to reveal how much they earned, thus learning whether their wives were misinforming them. Wives may not have correctly predict how their husbands would behave outside the lab (with proper foresight, the threat should have made them truthful in their information sharing). The risk of some women wrongly forecasting their husband's response is probably low, but not null. Participants provided their informed consent and were explicitly told that they could leave the lab at any time and that they would still be able to keep their show-up fee.

2.3 Descriptive statistics of survey data

Tables 1 to 3 provide some summary statistics of our surveys. Table 1 shows that couples in a marital arrangement typically report the male as the head of household. Most couples are in a long-term relationship (average 19 years), with 4.8 children on average.[8] There is a seven-year age difference on average (men 44, women 37 years old). About 49 percent of both men and women attended or completed primary school. Although the level of

[6]With 50% chance of drawing round 1 or round 2, maximum expected earnings are $(2,000+3,000)/2 = 2,500$ FCFA, representing US \$4.28 at current exchange rate and PPP \$11.64. The estimated annual income per capita is PPP \$1,700.

[7]Earnings as determined by the decision made were multiplied by one of the following factors $\{0, 0.5, 1, 1.5, 2\}$ with equal probability. See Appendix B for how we contextualized the lotteries in relation to weather shocks.

[8]Husbands also have a non-negligible number of offspring outside the official union. On average, they have 2 children with other women, while the wives' average is 0.3.

literacy is higher for men than for women, both spouses scored high on numeracy. Most of the game instructions were read out loud to allow for participants' varying literacy skills. Finally, there is some heterogeneity in living standards: slightly less than 10 percent reported experiencing hunger in the three months prior to the survey, while over 50 percent own a motorcycle.

We also asked respondents to report the items they spend the most on. The choice was between: (a) food, (b) schooling, (c) home repairs,[9] (d) children's health, (e) helping their own family members, (f) personal expenses. The first four categories concerned household public goods and the last two were meant to describe personal expense items. A higher proportion of men than of women report spending most of the income they have on schooling (29% vs. 22%). The larger gaps are for expenditures on health (almost 40% for men vs. less than 20% for women) and food (almost 35% for women vs. 21% for men), reflecting a gendered pattern of spending on household public goods. The private goods budget is the main item for almost 10% of men and for more than 23% of women. According to ethnographic evidence studying financial arrangements in West Africa (see Castilla (2013) for references), husbands provide a regular allowance ("chop money") to their wives for food expenses. This implies that the income they have is net of transfer to their spouse.

Agricultural production is described in Table 2. Males and females alike control the production of cotton on at least one plot belonging to the farm household. The average plot area controlled by women is 1.74 hectares. The one controlled by men is 7.34 hectares. Men and women interpret "control of one's plot" differently. Approximately 66 percent of women consider that they control a plot only if they have total control over the income it generates and over input choices. By comparison, 84 percent of men believe that they need to control both income and input before they can consider the plot their own.

Is information sharing between spouses imperfect as found in other parts of Africa (Merfeld, 2019)? Both male and female producers have a range of opportunities to hide income from production on their plots. When they both produce the same good, while the sales prices are likely to be common knowledge, there may be hidden information arising from the partially-observed plot yields. In Table 2, we obtain mixed evidence from self-reported data. When asked whether they have a good knowledge of the value of production from their spouse's main plot during the last agricultural season, 55 percent of males report that they know it very well, and 55 percent would still like to know more. Moreover, 57 percent of males believe that their spouse knows how much they produce on their main plot, and about 43 percent of males think their spouse would still like to know more. In contrast, only 40 percent of females report that they know how much their husband

[9]In the analysis, we discard this category as no woman reported it as her main budget item and less than 3 percent of men do.

produced on his main plot, and 46 percent believe their husband would still like to know more. As much as 60 percent women believe that their spouse knows how much they produce on their main plot, and only 39 percent of them think their spouse would still like to know more. Asymmetric information is one of the key factors affecting input allocation choices that we experimentally vary in the game.

Furthermore, according to the evidence collected in the subregion (Doss, 2018), men are responsible for making input allocation decisions (Table 3). In fact, according to female respondents, most husbands have a say in the allocation of inputs to female-controlled plots. In most cases, men are the sole decision-makers. On average across the different types of input (domestic and hired labor, fertilizers, and seeds) used on female plots, 61 percent of them make the allocation decision on their own, and 19 percent share the decision with their wife. On average, only 17 percent of women choose on their own the amounts of inputs used on their own plots. In the experiment, men are responsible for the allocation of inputs between plots of land.

2.4 Descriptive statistics of the experimental data

In Table 4, we compare the aggregate investment decisions, efficiency losses, and payoffs under each experimental condition. Despite full information, we find that baseline transfers did not maximize aggregate profits (first column of Table 4). On average, husbands invested 6.42 tokens in their wife's plot, falling short of the optimal 10-token investment that would have maximized household aggregate payoff. Their decisions resulted in average earnings of 1,287 FCFA for their wives. Husbands decided to forego 356 FCFA in aggregate earnings to the household in order to have full control of earnings. The decisions made by the husbands yielded an average efficiency loss of 17.8 percent.[10]

What does the empirical distribution of transfers look like when husbands are fully informed of the (higher) returns to investments to their wife's plot? We report the empirical distributions of the transfers in the two rounds in Figure 2. We observe 5 percent of men transferring 10 tokens and no mass at 0 in both rounds. No male participant opted to keep all the endowment for himself, and very few chose to make the efficient allocation decision. Most of them (an overwhelming 95 percent) failed to maximize aggregate profits. They chose to transfer some value strictly between 0 and B. These findings corroborate evidence from Udry (1996) and others. Based on the empirical distribution, almost 24 percent of husbands made low transfers (lesser or equal to 4), 29 percent of them made an intermediate transfer (from 4 to 6) and the remaining 47 percent transferred at least 6 tokens.

During the second round, participants exposed to ET also made their decision under

[10] On average, PPP $1.65.

full information, but here the returns on investments in their wife's plot were higher. Our findings for this group (column 2 of Table 4) are qualitatively consistent with those obtained from the baseline game. Even under increased returns on investments in their wife's plot, men failed to maximize household aggregate output, investing only slightly more tokens in their wife's plot, 6.72, than during the first round. Their decisions also led to significantly higher average earnings (2,038 FCFA) for wives and slightly lower average earnings (320 FCFA) for men. However, despite the increased investment in the wife's plot, the aggregate losses to the household were significantly greater. Households under ET experienced an average efficiency loss of 21.3 percent, 3.5 p.p. greater than during the first round, reflecting the larger marginal efficiency loss in the experimental condition for which returns are higher. In monetary terms, this represents an average of 640 FCFA in foregone earnings to the household.[11]

How do husbands respond to an increase in returns from their wife's plot when they do not precisely know the extent of the change but their wife does? Transfers under the *hidden information* treatment (HT) are slightly lower on average than under the *full information* treatment (ET); see column 3 of Table 4. Asymmetric information leads husbands to keep an additional 27 FCFA, which corresponds to a loss of 80 FCFA for their wife (53 FCFA loss to the household). This corresponds to a modest increase of 2 percentage points in efficiency loss due to asymmetric information. This finding is consistent with evidence collected on the role of asymmetric information in spouse investment and consumption decisions (Anderson and Baland, 2002; Ashraf, 2009; Castilla and Walker, 2013; Castilla, 2015), though not large in magnitude. While in both ET and HT, husbands knew that input on their wife's plot yielded higher returns, only those under ET knew precisely how much larger these returns were. In contrast, condition VT offers ex post verifiability on returns. Interestingly, the transfer decision made under VT is very similar to the one made under ET; see column 4 of Table 4. When spouses know that the exact information on returns is verifiable ex post, asymmetric information does not result in a loss in efficiency. Prior knowledge that information will be verifiable ex post suggests that communication between spouses is not sufficient to avoid losses due to information frictions.

3 Testing strategy and conceptual framework

In this section, we present our testing strategy and predictions. We use the experiment to design a strategy for analyzing the behavior of couples under private information and ex post verifiability. We derive predictions regarding the extent of transfers with and without asymmetries of information, as well as with and without ex post verifiability of information. To do so, we highlight two sources of inefficiencies in the allocation of productive resources:

[11] That is, PPP $2.97.

the inability of spouses to fully enforce their marital agreement and spouses' failure to communicate.

3.1 Transfers and public good provision

Consider a married couple who has to decide both on the allocation of productive inputs and on consumption, given individual preferences and incomes. In the following, we opt for a static framework for simplicity.[12]

Preferences We start by describing the preferences of the two spouses. We assume the following utility functions:[13]

$$U^H = c^H + v(Q),$$

for the husband, and

$$U^W = c^W + \alpha v(Q),$$

for the wife, where c^i is private consumption of each spouse $i = H, W$, and Q the level of public good in the household.[14] Spouses are linked through their joint consumption of public goods. Their contributions to household expenses for public goods are denoted by q^i so that $Q = q^H + q^W$.

We assume that the spouses have different preferences regarding the public good. We choose to model these differences through a scale parameter $\alpha > 1$. This assumption implies that the wife has a stronger preference for the public good than the husband. Although this assumption simplifies the analysis, it does not drive the results. The functions $v^i(.)$ satisfy the standard conditions $v^{i\prime} > 0$, $v^{i\prime\prime} < 0$, $v^{i\prime}(0) = \infty$, $v^{i\prime}(\infty) = 0$ and $v^i(0) = -\infty$. For the sake of simplicity, all other preference parameters are normalized to 1. In addition, we assume $v(.)$ to be the same for both spouses and to satisfy the assumptions stated above, as well as Decreasing Absolute Risk Aversion (DARA).

As the direct utility of each spouse is assumed to be of a quasi-linear form, this implies that utility is transferable (Bergstrom and Cornes, 1983).

[12] When information on production is asymmetric, repeated interactions may not restore efficiency if the information is not immediately verifiable. We thus expect efficiency losses due to private information even with repeated interactions. As in a static model, these losses may be avoided if the information becomes verifiable. We therefore opted for a static framework.

[13] Results hold for more general quasi-linear functions. There is heterogeneity in preferences between households, but we intentionally refrain from adding a household index to keep the notation simple.

[14] Spending on household public goods may include expenditures on children (e.g., food, education, health, clothing), as well as housing expenditures, including maintenance of the home. In many households, spouses may also care for one another. We discuss this natural extension after presenting our main proposition.

Income As discussed in the previous section, the experiment is meant to match the income-generating process in Togo, where spouses are employed in agriculture and farm separate plots.[15] Men and women farmers use the same technology and employ a common set of agricultural inputs. Farm incomes, Y^H and Y^W, are determined exogenously. We investigate how additional productive resources are allocated across plots to generate extra income for men and women under conditions on information and communication similar to those in the experiment.

In the contextualized investment game, participants are offered additional productive resources B. Husbands are responsible for deciding how to allocate inputs across plots. We denote by $t \in [0, B]$ the amount of input that a husband decides to transfer to his wife. To match the experiment, the use of additional inputs results in a marginal increase in production that is linear in the quantity of input used on each plot.[16] At this margin, an additional quantity of input $B - t$ on a male-managed plot yields income $B - t$ for him and an additional quantity of input t on a female-managed one yields kt for her. As in the experiment, we are interested in the situation where $k > 1$. In fact, our experiment only generates a small perturbation around the equilibrium behavior of the household. Around the equilibrium input use, less resources are used in the wife's plot for a given land quality, consistent with higher marginal returns from the wife's plot (Udry, 1996). In this setting, men (respectively, women) farmers' earnings are $(Y^H + B - t)$ (respectively, $(Y^W + kt)$). Transfers made during the experiment thus determine total household income, $(Y^H + B - t) + (Y^W + kt)$.

Optimal allocation decisions To match the first round of the experiment, we first consider the situation in which both income and returns from male- and female-managed plots are common knowledge. If spouses had been able to fully enforce a given share of resources after the experiment, the efficient production decision would have been to allocate all the resources to the wife's plot, as this is the choice that maximizes the household income available to finance private consumption and public goods (see Lemma A1 in the Appendix). Clearly, the findings from the first round of the experiment directly contradict this prediction. We therefore assume that spouses have limited enforcement possibilities on agreements concerning private consumption.[17] A man may, however, allow greater control of household income to a wife who spends some of it on household public goods. Hence,

[15] There is a growing trend towards individualization of plots of land in farm households (Guirkinger and Platteau, 2017).

[16] Recall the linear approximation used during the experiment to simplify computations for participants.

[17] Recent papers studying input allocations decisions in teams and couples (Fafchamps and Kebede, 2022; Bakhtiar et al., 2022) have also found inefficient allocations of inputs. They rationalize the findings by referring to endowment effects and preferences for fairness. However, the fact that they do not opt for the efficient input allocation and then agree on a sharing of the output "suggests that they do not, in fact, expect to be able to appropriate the surplus ex post" (as Bakhtiar et al., 2022, , p.26 suggest), implying the inability to enforce contracts. For the sake of simplicity, we therefore limit ourselves to assuming limited enforcement instead of directly modeling endowment effects or preferences for fairness, which would also be coherent with our results.

we can reinterpret the input allocation game as a public good provision game: the decision made in the game can be seen as an optimal public good provision problem.

Solving for optimal transfers, we find that husbands make some investment in the more productive income-generating activity of the household. Applying the Samuelson condition in this transferable utility setting implies that the division of income between spouses has no effect on public good allocation, only relative returns k do.[18] When k increases, the resources allocated to the more productive income-generating activity and public good contributions increase (see Proposition A1 in the Appendix). This result provides a test of whether transfers are meant to finance only private consumption of the wife or both her private consumption and public goods: if the first were true, an increase in k would imply a decrease in transfers, while the opposite is true (increase in k leads to an increase in t^*) in the second case. As reported in section 2.4, the increase in k is associated with a modest increase in the amount sent to the wife. We can thus conclude that these resources are also meant to finance household public goods.

In this framework, the inability of spouses to enforce marital agreements reveals spouses' conflicting interests in private consumption and drives the loss of allocative efficiency in production. On average, husbands do transfer a substantial part of the endowment to their wives (more than half), though not all of it. From the men's perspective, keeping part of the endowment to themselves is a way to secure income for their own consumption when they cannot reach a new agreement on the sharing of resources after the experiment. Since spouses have the ability to enforce agreements on the provision of household public goods, men expect that transferring resources to the wife does not alter optimal provision of these goods. Therefore investing in the more productive plot means that they will get to consume more of the household public good. The loss in efficiency from a suboptimal allocation of resources on the production side increases with the size of the enforcement problem on resource sharing, and decreases with how much the husband directly cares about his wife's private consumption. Conflicts over private consumption are associated with a loss of welfare for men.

3.2 Information and communication

In the very realistic setting with incomplete information, information frictions naturally give individuals control over their income, making it even harder to enforce marital agreements. In our setting, it is plausible that husbands are poorly informed about how much more productive their wife's plot is at the margin compared to their own (see Merfeld, 2019, for direct evidence on asymmetry of information on agricultural production in the farm household). Women may have private information on the returns from their plots.

[18] Also, for a given level of k, the heterogeneity in public good contributions is determined by the heterogeneity of preferences across households.

But even if sharing this information could be beneficial to them, they may be unable to communicate effectively with their husbands.

We now consider the equilibrium in public good provision when the wife's higher marginal returns are not completely observed by the husband. To match condition HT from our experimental setting, we assume that the husband knows that his wife's plot is more productive than his own, but not by how much (i.e., he does not know the exact value of k, but knows that $k > 1$). The wife is fully informed, meaning she knows the value of returns both from her plot and from her husband's plot. She is also aware that her husband does not have full information.

With the aim of determining whether the wife's message about returns from her plot is credible to the husband, we introduce a communication stage that takes place before the transfer stage. Communication is costless (cheap talk) and nonverifiable: the wife does not pay a direct utility cost for sending a particular message, neither at the moment of transmitting the information nor when allocations are realized. Thus, we introduce an additional stage in the game, making it a two-stage model: in the first stage, the information is transmitted; in the second, based on the signal m given by the wife, the husband decides how much to transfer, given the optimal contribution to the public good. Importantly, the man cannot verify ex post how much income his wife earned from the transfer of resources he made. Figure 1 provides a full description of the sequence of decisions in the setting with private information.

We study the perfect Bayesian equilibrium of the two-stage game. The communication technology of the wife corresponds to all possible k belonging to its probability distribution $F(k)$ defined over the interval $M = [\underline{k}, \overline{k}]$ so that $M = [\underline{k}, \overline{k}]$ is the set of feasible signals. The equilibrium consists of a family of signaling rules $h(m|k) : \int_M h(m|k)dm = 1$, an equilibrium of transfers $t(m)$, and public good contributions $Q(m)$ such that the wife solves the following problem:

$$\max_{m} \quad U^W(t(m), Q(m)|k),$$

and the husband solves:

$$\max_{t} \quad E[V^H|m].$$

Solving this problem, we obtain our main predictions (see Appendix A for the formal proof):

Proposition 1. *When k is uncertain and spouses have conflicting interests in consumption, communication is not effective and transfers are reduced. The reduction in transfers is smaller the higher the level of transfer under full information.*

First, when the returns from transferring resources to the wife are uncertain, the resources men are willing to allocate to the public good, a risky asset, decrease. When the husband is less informed about returns, this represents an increase in risk. When returns from the public good are more risky, the optimal level of the public good decreases. As a result, the man makes lower transfers to his wife when the returns are uncertain. These results are driven by the functional form of the husband utility that satisfies DARA.

Second, the effect of uncertain returns is expected to vary between households. Given DARA, it should be lower the higher the level of public good. Households with high levels of public good are also those for which the levels of transfer made under full information are the largest. Thus, we expect the effect of uncertain returns to be less severe for households with higher transfers under full information.

Finally, when the public good production function is not observable by the husband and the enforcement of marital agreements is limited and/or altruism is low, there are no signals m the woman could send to inform her husband about the returns from investment k which would affect the transfer. That is because, as in the full information setting, the husband uses transfers to reach the optimal level of public good investment. However, when the wife holds private information on the returns from input use on her plot, there is always an incentive for her to over-state the productivity differential so as to obtain a larger contribution from her husband. This means that she cannot send an informative message and that communication between spouses is not sufficient for limiting the damage from private information on returns from productive investments.

3.3 Empirical models

We expect asymmetries of information and communication failures to exacerbate inefficient allocations for households that suffer from issues of limited enforcement under full information (i.e., those who fail to make the efficient input allocation decision). We now lay out empirical models that exploit both inter- and intra-subject variations in transfers across information conditions to test two main predictions.

Testing for heterogeneous responses to asymmetric information (Prediction 1)
The first prediction is derived from Proposition 1.

Prediction 1. *Information asymmetries reduce transfers. The effect of asymmetries of information is stronger the lower the level of resource-sharing under full information.*

Asymmetric information is expected to aggravate allocative inefficiency in production. We expect transfers under private information to be smaller than transfers under full information for spouses who cannot fully enforce resource sharing agreements outside the lab, or that have low levels of altruism. Furthermore, the reduction in transfers due to private information (the loss of efficiency) is expected to be higher the lower the level of resource-sharing under full information.

To test this prediction, we used the random assignment of couples across experimental conditions in the second round of the game. We compare the transfers made under the *hidden information treatment* (HT) to the transfers made under full information. When testing Prediction 1, we assume that within-household communication is ineffective (i.e., that Prediction 2 holds). In this setting, it does not matter whether the information on returns from female-managed plots is provided before or after the decision, and both the *experimenter treatment* (ET) and the *verifiable treatment* (VT) are considered full information conditions. We present estimates where we pool ET and VT, as well as estimates where we compare transfers made under HT against each of the two.[19] Furthermore, we let the impact vary with the level of sharing under full information in the first round of the game, BT. To test whether the impact of *hidden information treatment* varies with the amounts of transfers BT, we exploit intersubject comparison across treatments during the second round of the experiment, as well as intrasubject comparison linking the transfers made by the same participants across rounds. We estimate the following empirical model by OLS over three working samples, namely all second-round observations, a sample restricted to observations under (HT+ET), and a sample restricted to (HT+VT):

$$y = \alpha + \beta HT + \gamma BT + \delta HT * BT + \varepsilon, \tag{1}$$

where y is the level of transfer made at round 2, HT takes value 1 for households randomly assigned to the *hidden treatment*, and value 0 otherwise, and BT are first-round transfers. We consider two specifications: with BT transfers in levels that enter linearly and with BT transfers as a binary variable that indicates low transfer levels ($BT \leq 4$). We are particularly interested in the parameter δ. According to Prediction 1, we expect δ to be negative.

Testing for the effect of ex post verifiability (Prediction 2) The second prediction is also derived from Proposition 1 and is meant to test the cheap-talk component of the model. In both rounds of the experiment, communication between spouses is possible before the husband makes the resource-sharing decision. Our model predicts that spouses will be unable to communicate effectively when information is asymmetric and nonverifiable, as in our cheap talk setup.

Prediction 2. *Asymmetries of information are the result of a communication failure between spouses, due to non-verifiability of information.*

[19]Pooling all the data from ET and VT increases precision.

By making private information verifiable ex post, we expect to constrain the wife to truthfully reveal it to her husband, thereby revealing the failure in communication between spouses. We now compare the choices made when both spouses know that the information will be revealed ex post (*verifiable information* treatment, or VT) with the choices made under *full information* (ET). If Prediction 2 holds, we expect no difference between VT and ET at any level of enforcement. In the following model,

$$y = \alpha + \beta VT + \gamma BT + \delta VT * BT + \varepsilon, \tag{2}$$

prediction 2 requires $\beta = \delta = 0$. The model is estimated by OLS on the sample restricted to observations under $(VT + ET)$.

To sum up, we expect *(i)* that the reduction in transfers under the *hidden information* relative to the *full information* treatment will be smaller when first-round transfers are higher (Prediction 1), *(ii)* that verifiable information will offset this adverse effect, with similar transfers being observed in the *verifiable information* and in the *full information* treatment for all levels of first round transfers (Prediction 2).[20] We now bring these predictions to the data.

4 Bringing the predictions to the data

In this section, we test the two implications of our model that concern choices made under private information. The first subsection considers the heterogeneity in the impact of private information. In the second subsection, we provide evidence on how ex post verifiability affects the impact of asymmetric information. In these two subsections, we entirely rely on observations of transfers in the two experimental rounds to test our predictions. In the last sub-section, we examine the external validity of our findings using survey data.

4.1 Testing Prediction 1: Asymmetric information

Table 5 presents the estimation results for Equation 1. This table is composed of two panels and three columns. The top panel corresponds to the specification of the model where transfers made during the baseline game enter linearly. In the bottom one, a binary variable indicating low first-round transfers ($BT \leq 4$) is included in place of the amount of transfers made during baseline game. In the first column, using all second-round data, we report impact estimates comparing transfers made under HT to those made under $(ET + VT)$. In the second column, we contrast transfers made under HT to those made under ET. In the third, we compare the transfers made under HT with those made under

[20] When Prediction 2 holds, the difference in average transfers across the *verifiable information* treatment and the *hidden information* treatment should be similar to the difference in average transfers across the *full information* treatment and the *hidden information* treatment.

VT. Figures 3, 4, and 5 represent the heterogeneous effects of HT in relation to first-round transfers in the three samples.

In the top panel, the coefficients for the direct treatment effect (line 1) and the interaction term (line 3) imply that for each additional unit of first-round transfer, the negative effect of asymmetric information (line 1) is reduced by 0.2 units (line 3). The magnitude of the effect is similar in column 1, 2 and 3, although only significant ($p = 0.05$) when $ET + VT$ are combined. As expected from Prediction 1, not only does private information reduce transfers (line 1), but the reduction in transfers due to private information decreases as the amount transferred under full information increases (line 3).

Estimates provided in the bottom panel confirm this finding. We find that the impact of asymmetric information is small and insignificant for those who made intermediate/high transfers in the baseline round (line 1). Only those who made low transfers during this round respond to the information friction by decreasing transfer to their wife's plot by about 2 tokens (out of 10), a statistically significant drop. This drop results in an efficiency loss of 13 percentage points, corresponding to an 18 percent change.[21] This effect is similar and statistically significant in all three specifications (columns 1 to 3), although, as in the top panel, the grouping $ET + VT$ provides more precise estimates.

In summary, Table 5 not only shows that private information is detrimental to production efficiency - Prediction 1 is much sharper than that. We find that the loss in efficiency due to private information decreases as the amount transferred under full information increases. The data supports Prediction 1, at least if we assume that Prediction 2 is valid (that is, based on pooled full information treatments $ET+VT$). The estimates in the bottom panel indicate that only households with low transfers under full information respond to private information, incurring an extra loss in efficiency. In the next section, we test Prediction 2.

4.2 Testing Prediction 2: Ex post verifiability

Table 6 presents the estimation results from Equation 2: column 1 corresponds to the specification for which BT transfer levels enter linearly; column 2 corresponds to the one for which they enter as a binary indicator for low transfers. According to the estimates in Table 6, there is neither direct (line 1) nor differential effect of the treatment in relation to transfers in the first round (line 3 and line 5). A graphical representation is offered in Figure 6. Although some households suffer an efficiency loss due to the information friction (Table 5), this loss can be avoided when the information is verifiable ex post (Table 6). This result is consistent with women truthfully communicating with their husband about

[21]The decrease in efficiency for those who made low BT transfers is $2/30 * 1.9 = 0.13$. With full information ($HT = 0$), these households would experience an efficiency loss of 0.69. The relative loss due to private information for these households is therefore $0.13/0.69 = 0.18$.

the true value of their returns when they know it will be verifiable. Our finding points to communication failures between spouses when information is asymmetric and supports Prediction 2.

In summary, based on our experimental data, we find evidence of inefficient allocation of productive resources, consistent with findings from many observational studies. Moreover, we find that households' responses to private information are heterogeneous, consistent with evidence from some experimental studies. Two pieces of evidence are consistent with our predictions. First, the efficiency loss due to asymmetric information differs according to the allocation choices previously observed under full information. It is stronger for households with higher efficiency loss under full information. In particular, the extra loss is concentrated among the most inefficient households (transfers of 4 input units or less) during the baseline game.

Second, we find that the loss in productive efficiency cannot be avoided by cheap talk. Households make similar choices under the full and verifiable treatments. This result holds throughout the distribution of baseline transfers.

Finally, the conclusions for testing Prediction 1 and 2 are robust to different thresholds for defining low transfers, as shown in Figures 3-6 and table A1 in the online Appendix. In Tables 5 and 6, the indicator of low first-round transfers takes the value 1 for $BT \leq 4$ and 0 otherwise. Figures 3-6 show the coefficients on the interactions between the treatment indicator and three indicators for first-round transfers using two threshold values (i.e. three indicator variables for first-round transfers). Table A1 reports treatment coefficients for separate sub-samples defined based on first-round transfer amounts. Consistent with Table 5, treatment coefficients in the top three panel are large and significant for households with low first-round transfers. Consistent with Table 6, the treatment coefficients are non significant, independantly of the threshold value of first-round transfers used to restrict the sample. In the next section, we also investigate further the mechanisms that could drive the results.

4.3 Additional evidence from survey data.

External validity In Table 7, we investigate the correlation between the real-life responsibilities of each spouse in household public good provision as described in the survey data and the transfers from the husband to the wife during the experiment.[22] We expect higher transfers in households in which women spend the largest part of their income on household public goods (food, health and schooling) as opposed to spending it on private uses (personal expenses, transfers to her family). Similarly, transfers should be lower when men spend most of their income on public goods.

[22]We asked men and women to identify the category on which they spend the most (food, schooling, health, and personal expenses or transfers to own family). See descriptive statistics in Table (1).

We test the correlation between transfers from husbands and household public good spending by their wives in columns (1) and (2). We find that when food and health expenses are women's main spending items (column 1), transfers in the baseline game increase of almost 2 and 1.75 units respectively.[23] In column (2), a similar involvement of wives in public good provision is also associated with higher transfers in the second round by almost 1 and 0.87 units respectively. The correlation with transfers when women declare spending most of their income on schooling is not statistically significant. The correlation between transfers and husbands' participation in public good provision is negative. These negative correlations become large in magnitude and significant in specification (4), when we include informational treatments and restrict the sample to exclude observations for which the age of the women is missing.

We also test the limited enforcement hypothesis using survey data. We include as a covariate in Table 7 the number of children the man has with women other than his current wife (and game participant). We interpret this variable as a proxy for limited enforcement in the couple. We find that the average man who has 2 children outside the couple reduces the transfers made to his wife by about 0.2 (columns (2) to (4)).

Columns (3) and (4) of the same table test whether the precision of the treatment effect increases when we control for variables that describe household financial arrangements. The hidden information treatment effect becomes more precisely estimated in column (4) when we exclude observations for which the wife's age is missing and include covariates describing household financial arrangements. Transfers are lower by 1.37 units in the hidden information treatment compared to the full information treatment.

Direct evidence on mechanisms from survey data. Finally, Table 8 directly tests the effects of information treatments on knowledge men have of returns from their wife's plot. After the experiment, the men were asked to estimate the return in the second round. Under both full and verifiable treatment conditions, men should report an accurate estimate of the parameter. We also expect a less accurate report from men in the hidden-information treatment.

In the upper panel of Table 8, the dependent variable is an indicator variable for whether the husband reports a value different from 3 (the correct one). Being in the HT treatment almost doubles the probability of not knowing the correct value of the productivity compared to being in the other two treatments (column (1)), a statistically significant difference at 5 percent level. According to columns (2) and (3), the increase is approximately 50% and 250% compared to VT and ET, respectively (only the latter is statistically significant at 1 percent). Column (4) tests the effect of verifiability by comparing VT with ET. Being in VT also decreases the probability of correctly estimating

[23] A one standard deviation on units transferred in baseline game is 2.31.

the return from investing in a female-managed plot, but the effect is much lower than that of the *HT* treatment (though the difference is not statistically significant, as reported in the last line of the top panel where we compare coefficients in columns (3) and (4)).

In the bottom panel of Table 8, we use the continuous variable of productivity as the dependent variable. The results confirm that women have difficulty transmitting information to their husband as found in the existing literature (Conlon et al., 2022). Men tend to systematically underestimate the true value of the return as indicated by the negative signs on the treatment coefficients. This effect is the largest and statistically significant at 10 percent when information is not verifiable (column 3), in accordance with the findings in the top panel. In summary, the communication failure between spouses is a finding supported by data from the lab as well as survey data.

5 Conclusion

Female farmers are often involved in agricultural production on the same farm as their spouse, cultivating different plots of land. Here, we have proposed a model that explains allocative inefficiencies in production in the farm household. The way spouses make decisions about consumption shapes their production decisions and may result in a misallocation of resources across plots. Asymmetric information within the household further exacerbates allocative inefficiency. In addition, communication between spouses cannot be relied on to alleviate information frictions.

We have reported findings from a lab-in-the-field experiment to test for cheap talk inside the household. Our participants are couples of cotton farm producers in Togo and the game is contextualized to represent actual input allocation decisions across female-managed and male-managed plots with higher returns on the former than on the latter. We experimentally manipulated the information available at the time of decision-making. With full information on returns from the plots, most households incurred an efficiency loss from misallocation. To rationalize this finding, we have shown that conflicting interests regarding private consumption and low altruism limit the ability of spouses to enforce their agreement. We brought in two other predictions to the data. Consistent with the first prediction, we found that private information on returns exacerbates inefficiencies and that this effect is concentrated among those who incurred the largest losses under full information. Consistent with the second prediction, choices made under asymmetric but ex post verifiable information are similar on average to those made under full information. In our setting, failure to communicate was shown to be responsible for the extra loss incurred under information asymmetry.

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6 Tables and Figures

Table 1: Descriptive statistics on male and female socio-demographic characteristics (N=141)

		Men	Women
Head of household/spouse		.94	.96
		(.23)	(.18)
Age		43.94	37.15
		(1.1)	(1.2)
Education level (%)			
	No formal schooling	17.73	43.26
	Primary level	34.75	45.39
	Completed primary level	13.48	4.26
	Middle-secondary level	26.95	6.38
	Completed middle-secondary level	2.84	.71
	High school	3.55	0
	Higher education	.71	0
Test scores (out of 10)			
	Reading	6.63	2.24
		(4.62)	(4)
	Writing	6.12	2.96
		(4.47)	(4.20)
	Counting	9.64	8.12
		(1.85)	(3.84)
	Numeracy	7.5	3.93
		(3.98)	(4.71)
Number of children with partner		4.75	
		(2.01)	
Number of children from other unions		2.02	0.3
		(3.58)	(1.06)
Primary spending (%)			
	Food	21.28	34.75
	Schooling	29.08	22.7
	Children's health	39.72	19.15
	Personal expenses or transfers to own family	9.93	23.4
Household size		8.76	
		(4.1)	
Years in marital union		19.01	
		(8.98)	
Own a bicycle		.44	
		(.50)	
Own a motorcycle		.53	
		(.50)	
Experienced hunger in the last 3 months		.08	
		(.28)	

Standard deviation between parenthesis, below average.

Table 2: Descriptive statistics on male and female agricultural production (N=141)

		Men	Women
Total plot area farmed (in ha)		7.34	1.74
		(6.98)	(1.96)
Value of production (FCFA)		386 806	92 452
		(864 759)	(86 329)
Main plot			
	Reports having control over income and input (%)	82.9	65.9
	Own time spent per week (hrs)	33.47	26.14
		(11.2)	(11.1)
	Spouse's time spent per week (hrs)	22.98	16.46
		(13.94)	(12.56)
Knowledge of production from spouse's main plot (last season)			
	Mostly knows (%)	73.75	57.44
	Wants to know more (%)	55.31	46.1
Beliefs on knowledge of production from one own's plot (last season)			
	Believe spouse mostly know (%)	83.45	81.56
	Believe spouse wants to know more (%)	43.26	39

Standard deviation between parenthesis, below average.

Table 3: Control over decision on input allocation to female plots (N=141)

	% Women Only	% Men Only	% Jointly
Family labor	17	63.1	19.1
Hired labor	7.1	64.5	20.5
Fertilizer	17	63.8	18.4
Seeds	27.6	53.2	18.4

Table 4: Descriptive statistics on transfers, efficiency and payoffs by round and treatment condition (N=141)

	Baseline game (Round 1)	Round 2		
	(1)	(2)	(3)	(4)
	Avg. baseline game (SD)	Avg. in ET (SD)	Avg. in HT (SD)	Avg. in VT (SD)
Tokens transferred to the wife	6.42	6.79	6.52	6.86
	(2.31)	(2.26)	(2.30)	(1.86)
Efficiency loss to the household	.17	.21	.23	.20
	(.11)	(.15)	(.15)	(.15)
Male payoffs	356	320	347	313
	(231.2)	(226.1)	(230.9)	(186.5)
Female payoffs	1287	2038.4	1958.8	2058.8
	(462.5)	(678.4)	(692.8)	(559.7)
Household aggregate payoffs	1644	2358	2305	2372
	(231.2)	(452.3)	(461.9)	(373.1)

ET: experimenter treatment (full information), HT: hidden information treatment; VT: ex-post verifiable information treatment.

Table 5: Prediction 1 - Impacts of private information on transfers in relation to transfers made in the first round under full information

	(1) HT vs (ET+VT)	(2) HT vs ET	(3) HT vs VT
Direct treatment effect (HT)	-1.58*	-1.54	-1.62
	(0.83)	(1.02)	(1.12)
First-round transfers (continuous)	0.62***	0.62***	0.61***
	(0.09)	(0.11)	(0.13)
Treatment x First-round transfers	0.22**	0.21	0.23
	(0.11)	(0.13)	(0.15)
Intercept	2.83***	2.79***	2.87***
	(0.66)	(0.88)	(1.00)
Direct treatment effect	0.36	0.29	0.40
	(0.33)	(0.46)	(0.36)
First-round transfers (binary)	-1.87***	-1.88**	-1.91**
	(0.57)	(0.83)	(0.80)
Treatment x First-round transfers	-1.91**	-1.91*	-1.87*
	(0.76)	(0.98)	(0.95)
Intercept	7.21***	7.28***	7.16***
	(0.21)	(0.38)	(0.25)
N	141	90	102

ET: experimenter treatment (full information), HT: hidden information treatment; VT: ex-post verifiable information treatment. Robust standard errors in parentheses. In the top panel, first-round transfers (continuous) is a continuous measure of transfers made during the first round. In the bottom panel, first-round transfers (binary) is a binary indicator that takes value 1 for transfer levels lesser or equal to 4 and value 0 otherwise. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Prediction 2 - Impacts of ex post verifiability of information on transfers in relation to transfers made during the first round under full information

	VT vs ET	
	(1)	(2)
Direct treatment effect (VT)	0.08	-0.11
	(1.34)	(0.46)
First-round transfers (continuous)	0.62***	
	(0.11)	
Treatment x First-round transfers	-0.02	
	(0.17)	
First-round transfers (binary)		-1.88**
		(0.83)
Treatment x First-round transfers		-0.04
		(1.16)
Intercept	2.79***	7.28***
	(0.88)	(0.38)
N	90	90

ET: experimenter treatment (full information), HT: hidden information treatment; VT: ex post verifiable information treatment. Robust standard errors in parentheses. In the top panel, First-round transfers (continuous) is a continuous measure of transfers made during the first round. In the bottom panel, First-round transfers (binary) is a binary indicator that takes value 1 for transfer levels lesser or equal to 4 and value 0 otherwise. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Transfers: Correlation with external variables

	(1) First-round transfers	(2) Second-round transfers	(3) Second-round transfers	(4) Second-round transfers
Treatment Effect HT			-0.70	-1.37**
			(0.52)	(0.58)
Treatment Effect VT			-0.25	-0.78
			(0.49)	(0.56)
Schooling budget (husband)	-0.73	-0.79	-0.91	-1.97***
	(0.67)	(0.61)	(0.63)	(0.70)
Food budget (husband)	-0.99	-0.76	-0.87	-1.62**
	(0.66)	(0.63)	(0.64)	(0.64)
Health budget (husband)	-0.47	-0.71	-0.87	-1.41**
	(0.62)	(0.57)	(0.60)	(0.62)
Schooling budget (wife)	0.12	-0.50	-0.53	-0.83
	(0.64)	(0.60)	(0.59)	(0.71)
Food budget (wife)	1.99***	0.99**	1.04**	0.95*
	(0.51)	(0.48)	(0.48)	(0.53)
Health budget (wife)	1.75***	0.87	0.78	0.43
	(0.60)	(0.54)	(0.55)	(0.58)
# Children (with game partner)	-0.04	0.02	0.01	0.04
	(0.10)	(0.09)	(0.10)	(0.11)
# Children (with others)	-0.05	-0.08	-0.09*	-0.11
	(0.07)	(0.05)	(0.05)	(0.07)
N	133	133	133	102

Robust standard errors in parentheses.
Schooling, food, health budget takes value 1 if the item is reported as i's primary spending (i =husband, wife). Omitted category: Other budget.
We control for: husband's and wife's income, proxied by the value of agricultural production from their main plot, husband's and wife's age, the husband's number of children with the game participant, the number of children he has with other partners, the wife's number of children with other partners.
In column (4) the sample is restricted to women with non-missing age.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Knowledge of wife's plot productivity by the husband.

	(1) HT vs. (ET+VT)	(2) HT vs. VT	(3) HT vs. ET	(4) VT vs. ET
	Dummy: Wrong productivity			
Direct treatment effect	0.22**	0.14	0.32***	0.18**
	(0.09)	(0.10)	(0.09)	(0.09)
Intercept	0.23***	0.31***	0.13**	0.13**
	(0.05)	(0.07)	(0.05)	(0.05)
N	135	96	86	88
Test (1) = (3)	4.20			
	[0.04]			
Test (2) = (1)	4.11			
	[0.04]			
Test (3) = (4)	2.05			
	[0.15]			
	Value of productivity			
Direct treatment effect	-0.20	-0.17	-0.24*	-0.06
	(0.12)	(0.14)	(0.14)	(0.12)
Intercept	2.86***	2.83***	2.89***	2.89***
	(0.06)	(0.08)	(0.08)	(0.08)
N	129	91	82	85
Test (1) = (3)	0.31			
	[0.57]			
Test (2) = (1)	0.31			
	[0.57]			
Test (3) = (4)	1.61			
	[0.20]			

ET: experimenter treatment (full information), HT: hidden information treatment; VT: ex post verifiable information treatment. Robust standard errors in parentheses. P-value for the chi-square test of equality across models under brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 1: Timeline of theoretical framework

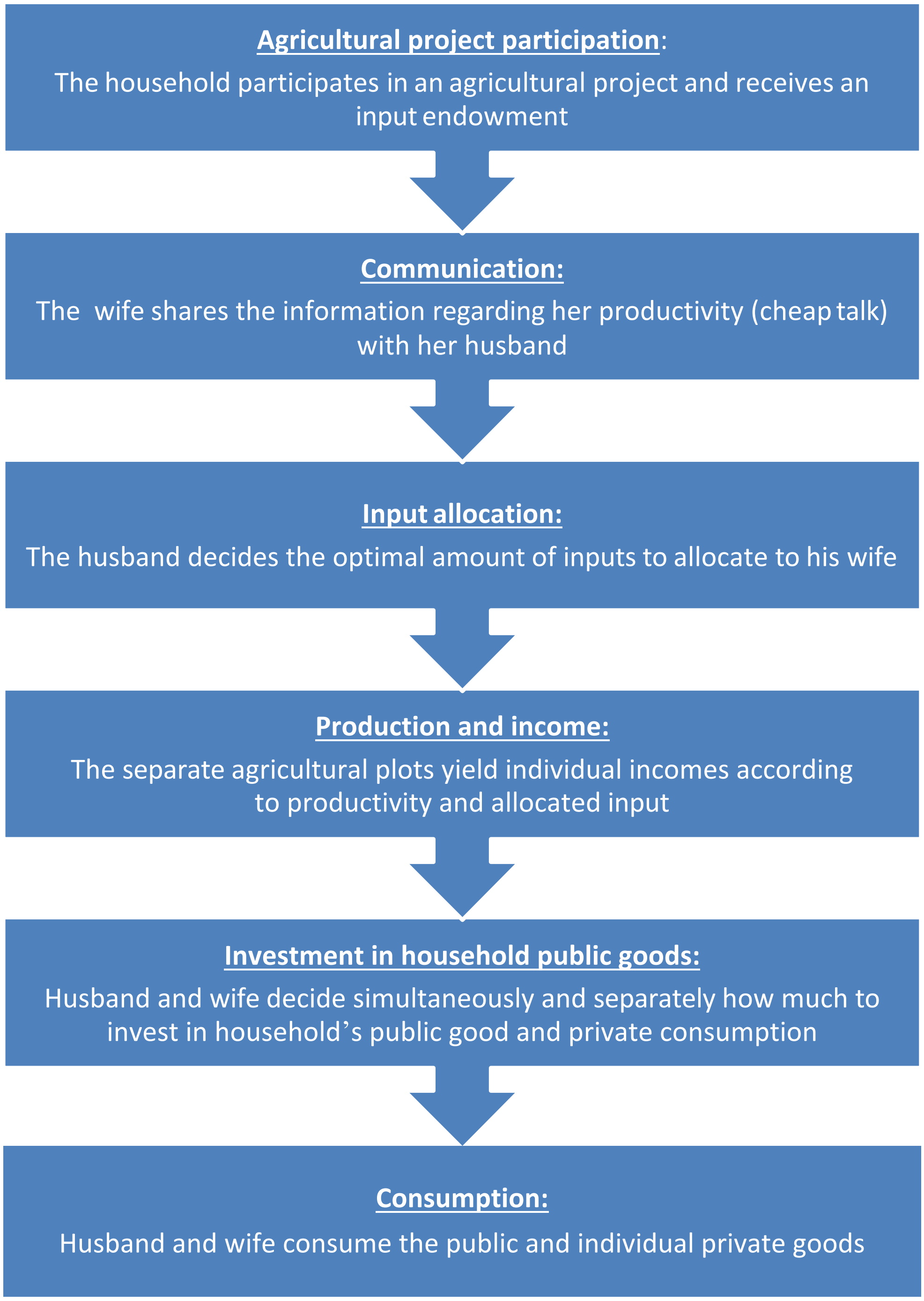
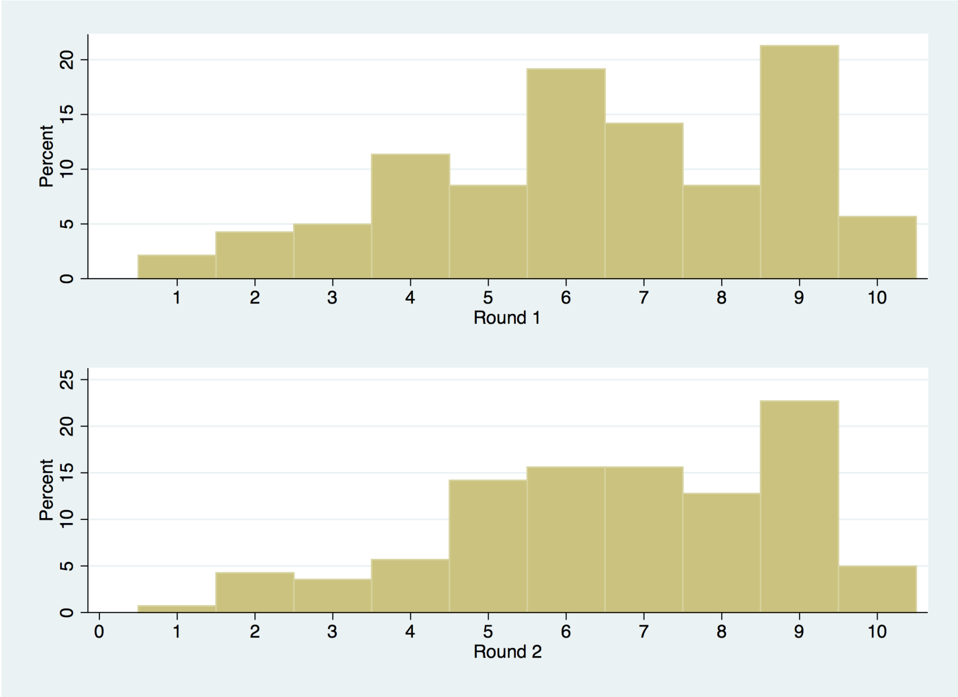
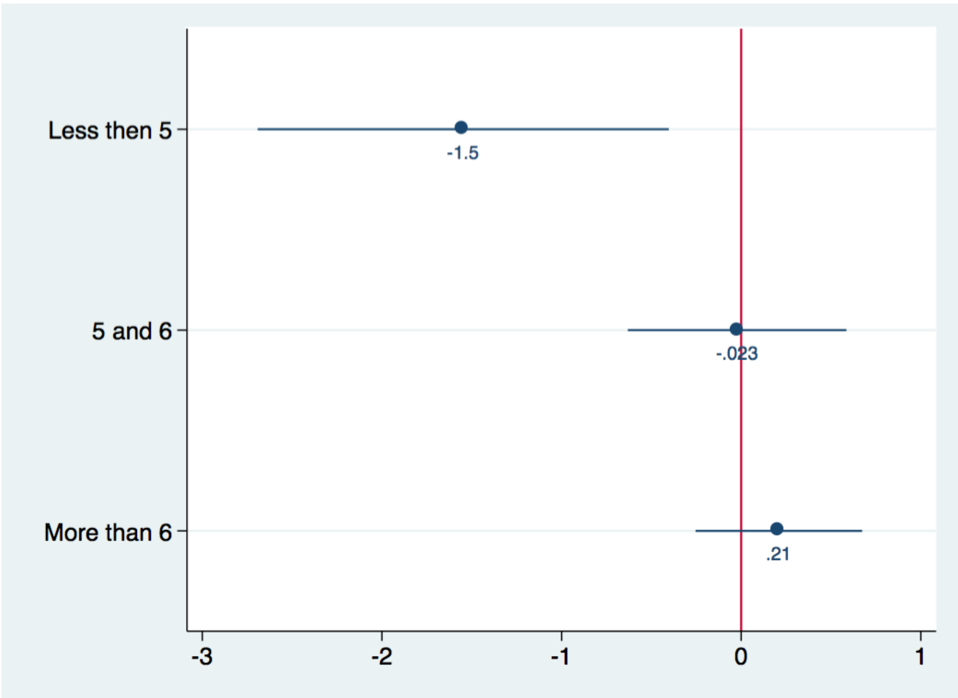


Figure 2: Distribution of transfers



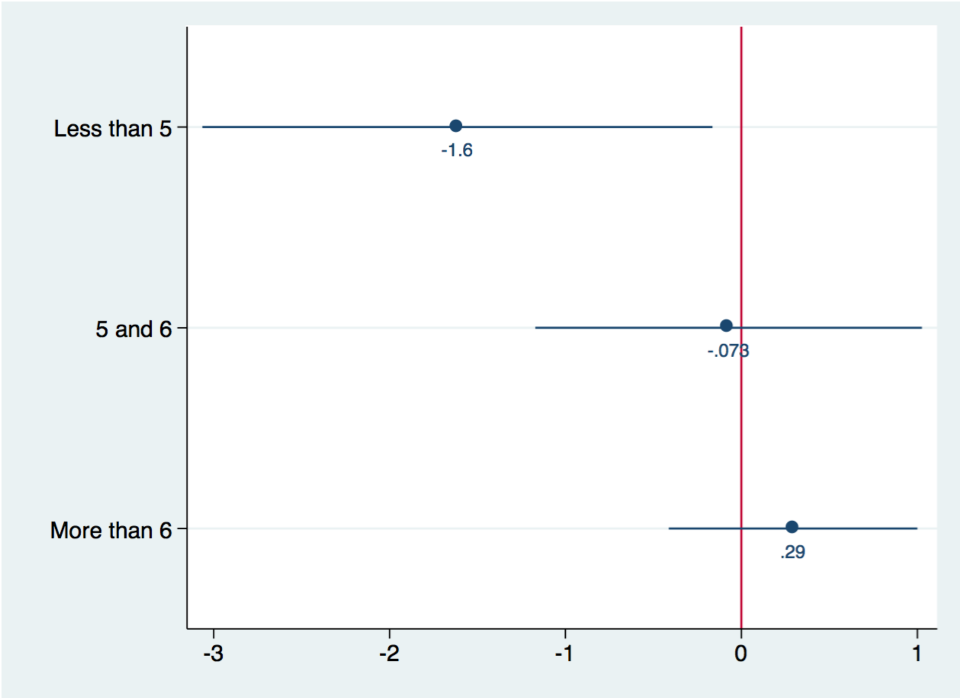
The bottom panel reports second-round contributions for all three experimental conditions.

Figure 3: Heterogeneous effects in relation to first-round transfers - Hidden information vs. Full/Verifiable information



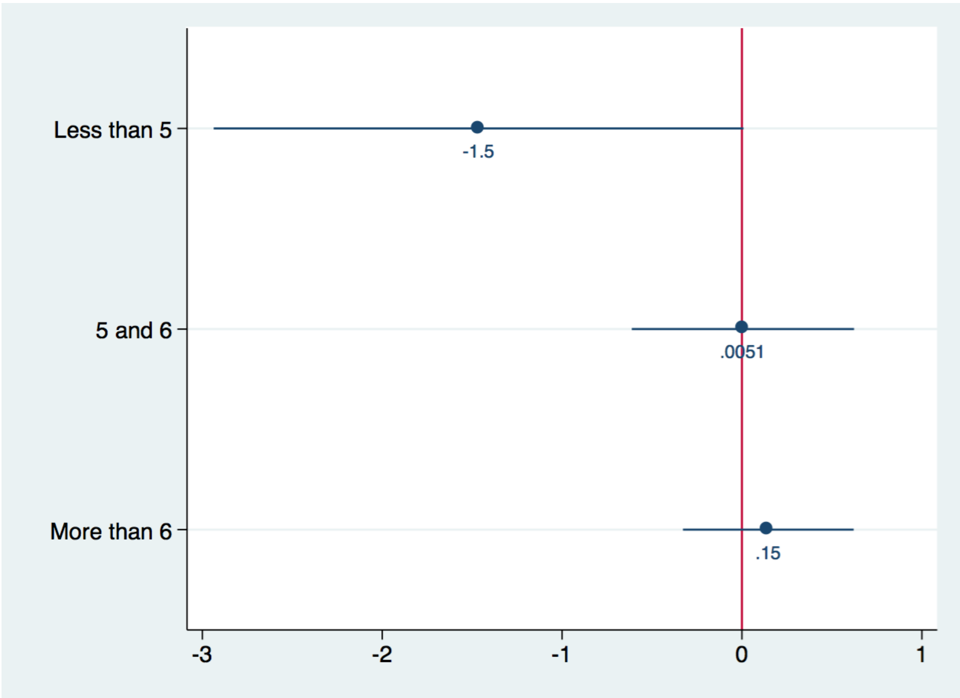
Horizontal segments are 95% confidence intervals.

Figure 4: Heterogeneous effects in relation to first-round transfers - Hidden information vs. Full information



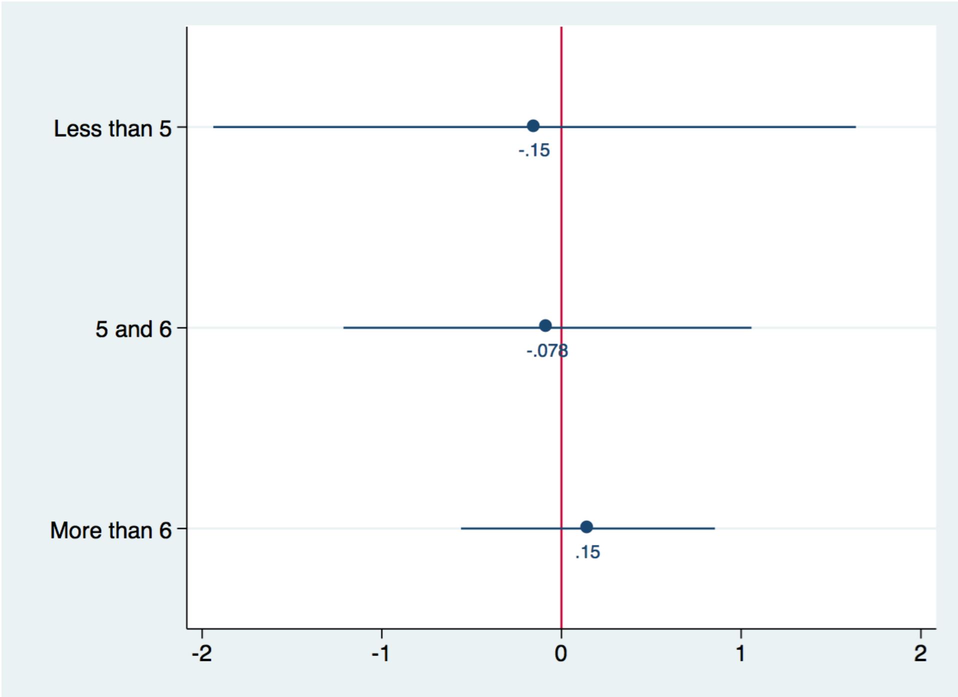
Horizontal segments are 95% confidence intervals.

Figure 5: Heterogeneous effects in relation to first-round transfers - Hidden information vs. Verifiable information



Horizontal segments are 95% confidence intervals.

Figure 6: Heterogeneous effects in relation to first-round transfers - Verifiable information vs. full information



Horizontal segments are 95% confidence intervals.

Communication and production in the family farm: Theory and evidence from rural Togo

Online Appendix

5th March 2025

A Theoretical Appendix: Proofs

Lemma A1. *If spouses can fully enforce a given share of resources after the experiment, the efficient production decision is to allocate all the resources to the wife's plot. This choice maximizes the household income available to finance private consumption and public goods.*

Proof. Lemma A1 (Efficient transfers)
Let γ be the Pareto weight of the wife and $(1-\gamma)$ that of the husband. Household aggregate income is: $(Y^H + B - t) + (Y^w + kt)$. Thus, the household maximization problem is as follows:

$$\text{Max}\, \gamma U^W + (1-\gamma)U^H$$
$$\text{subject to } c^H + c^W + Q \leq Y^H + Y^W + B + (k-1)t$$

which yields the following optimal condition for public good provision and private consumption (c^{H*}, c^{W*}, Q^*) : [24]

$$(\gamma + (1-\gamma)\alpha)v'(Q^*) = 1$$
$$c^{H*} = \gamma(Y^H + Y^W + B + (k-1)t - Q^*)$$
$$c^{W*} = (1-\gamma)(Y^H + Y^W + B + (k-1)t - Q^*)$$

This is clearly maximized for $t^* = B$. ■

Full information. First round equilibrium The input allocation game is set up as a public good provision game. In our setting, transferable utility implies the following result:

Proposition A1. *When utility is transferable and the wife consumes a positive level of private consumption, efficiency in public good provision implies that the division of income between spouses does not have any effect on the public good allocation, only relative productivity k does. When k increases, public good contributions increase. If $k > 1$, husbands use transfers to finance public good provision.*

Proof. Proposition A1 (First round equilibrium). We characterize optimal transfers in a household with transferable utility and partial enforcement. Formally, these assumptions imply that: (i) the efficient level of public good provision, as defined by the Samuelson condition,[25] can be reached; (ii) no agreement on private consumption can be enforced; (iii) the wife has a positive level of private consumption guaranteed by the husband, either due to some social norms or altruism. If transfers served to finance women's public good contributions, the Samuelson condition would be: $(k+\alpha)v'(Q) = 1$. If, instead, transfers only served to finance women's private consumption, the condition would be $(\frac{k+\alpha}{k})v'(Q) = 1$.
We solve the model by backward induction. In the first stage, the husband determines the optimal level of transfers, t^*, taking as given the intra-household equilibrium of the second stage. Thus, he solves the following problem:

$$\max_t \quad V^H(t)$$

$$\text{subject to } t \leq B.$$

[24]Throughout, prices are normalized to 1 for the sake of simplicity.
[25]The implicit Samuelson condition, when both spouses consume a positive level of private consumption, is $MRS^H + MRS^W = 1$.

where $V^H(t)$ is the indirect utility of the husband.
First, we describe the second stage equilibrium. Let's define $\underline{c}^W$ as the minimum level of consumption that needs to be granted to the wife. Let's also define as $\overline{Q}$ the level of public good provision when $k = 1$ (productivity of the husband's and the wife's plots are the same). When $k = 1$, $\overline{Q}$ satisfies the Samuelson condition: $(1 + \alpha)v'(\overline{Q}) = 1$. In this case, the optimal level of public good is the same regardless of whether the income used to financed it is coming from the husband's or the wife's plot. If a transfer were made, it would be $t_1^* = \underline{c}^W + \overline{Q}$.
Let us now consider the case when $k > 1$ (consistent with the experimental design). To maximize his utility, the husband makes a transfer $t^* > t_1^*$ to the wife. This is because the transfer now finances a higher optimal level of public good $\overline{\overline{Q}} > \overline{Q}$, in addition to financing his wife's additional private consumption $\frac{\underline{c}^W}{\alpha}$. When $k > 1$, $\overline{\overline{Q}}$ must satisfy: $(k + \alpha)v'(\overline{\overline{Q}}) = 1$. A husband always finances public goods through transfers to his wife because he gets to consume more public good with a transfer than if he were to finance it directly. Hence there will be a higher indirect utility with transfers as compared to when he keeps the same amount for himself. ■

Incomplete information. Second round equilibrium We now prove our main result. We start by showing that the equilibrium transfer t^{**} under incomplete information is lower than the one under full information t^*. We then show that the reduction in transfers is smaller the higher the level of transfers under full information. We end the proof by showing that communication is ineffective.

Proof. Proposition 1 (Second round equilibrium) When k is uncertain, $t^{**} < t^*$. This result is entirely driven by our assumption on the shape of the utility function. We assume spouses to be risk-averse and ARA to be decreasing, with the Relative Risk Aversion of the husband equal to 1.
To show this result, first note that the optimal level of public good Q^{**} is the one that solves:

$$\int_{\underline{k}}^{\overline{k}} (x + \alpha)v'(Q(x))F(x)dx = 1.$$

Since the second derivative of the optimality condition with respect to k is negative, the optimal Q^{**} must be lower than with full information. More formally, by implicit differentiation of the optimality condition, we have:

$$\frac{\partial Q^*}{\partial \sigma^k} = \frac{\int_{\underline{k}}^{\overline{k}} v'(Q)F_\sigma(k)dk}{\int_{\underline{k}}^{\overline{k}} v'(Q)F(k)dk} + \frac{\int_{\underline{k}}^{\overline{k}} v'(Q)F_\sigma(k)dk}{-\int_{\underline{k}}^{\overline{k}} v''(Q)F(k)dk}$$

where σ^k is the variance of the distribution of k, representing risk. Since $v' > 0$ and $v'' < 0$, both denominators are positive. Hence, the sign of $\frac{\partial Q^{**}}{\partial \sigma^k}$ is given by the common numerator, $\int_{\underline{k}}^{\overline{k}} v'(Q)F_\sigma(k)dk$. The term is negative because the second derivative of the FOC with respect to k is negative, a property shared by all DARA utility functions (Diamond and Stiglitz (1974)).

We now show that the reduction is lower when the transfers under full information are higher. Let us consider two level of transfers, t_1 and t_2 that correspond to two levels of public good provision $Q_2 > Q_1$. Since higher public good contributions require higher transfers (Proposition A1), it follows that $t_2 > t_1$. Since husbands' Absolute Risk Aversion $ARA = -\frac{v'}{v''}$ is decreasing in the level of public good provision that is reached in the household, it also follows that $ARA_1 > ARA_2$. For the last step, we apply Corollary 1 in Diamond and Stiglitz (1974). We obtain that the risky asset t decreases less as the variance increases at higher levels of Q. Formally:

$$|\frac{\partial t_1}{\partial \sigma^k}| > |\frac{\partial t_2}{\partial \sigma^k}|$$

It remains to solve for the first stage of the game. For all productivity levels, if contracts on private consumption are not enforceable and there is no altruism, all types prefer to send the same message and no communication is possible in equilibrium (Crawford and Sobel, 1982). Suppose that women over-state their productivity advantage to get their husband to send higher transfers. They would set $m^H = \overline{k}$ when the productivity realization is k. Indeed, from the best reaction function of the husband with full information, $t^*(\overline{k}) = t^{max*}$, meaning that when the wife sends the message m^H, the husband sends the highest transfer. Since the indirect utility of the wife increases with t, her incentive is to declare $m^H = \overline{k}$ regardless of the productivity realisation. This, in turn, implies that men will not update their prior based on the message sent by the wife: $p(k|m) = F(k)$.
■

B Experimental Design

The following is a brief description of the experimental games, with a summary of the protocols (full version available in French and Ewe upon request).

Context and general instructions Each couple is invited to participate in two games. The first-round game is the same for everyone. Subsequently, three versions of the second-round game (ET, VT and HT in the text) are randomly assigned across participants. At registration, each couple receives an identification tag featuring the letter corresponding to their Game 2 assignment and their order of arrival.
Husbands and wives are placed in separate areas and assigned individual experimenters. To ensure confidentiality, experimenter-participant pairs are located beyond hearing distance of each other. During the experiment, each experimenter reads the instructions aloud, explains them and tests the participant's understanding with questions. The game moves on only after each participant provides correct answers to all questions.
Participants are told they can each earn money during the games, the amount they receive being based both on the decisions made by the husband during the games and on the outcomes of two lotteries. These lotteries take place at the end of the games. The first lottery determines whether first-round gains or second-round gains will apply. The second lottery can increase or decrease the amount selected in the first lottery – there is even a chance of earning nothing. To place the second lottery in a realistic context, the experimenter refers to uncertainty in agricultural production related to unexpected events (weather, pests) that may act as positive or negative shocks and reminds participants how, when these events are extreme, farmers may lose everything.

Both husbands and wives know that their gains will be partly determined by the lotteries. Although they know the basic structure of the lotteries, the wives are not invited to observe the lottery outcome. Payments are made in an individual and confidential way to each spouse. The husbands are informed that no one, including their wife, will know or can guess the decision they made and how much they will earn. The wives are informed that no one, except their husband, will know or can guess how much they will earn.

First-round (Base game, same for all): Both men and women know the following:

- There are two separate plots of farmland. The woman is responsible for one of them, the man for the other.
- They have an endowment of 10 units of input to allocate between the two plots.
- Returns on each plot are constant, but they are twice as high on the female's plot as on the male's. In other words, yields increase linearly with the amount of input units used on each plot, but the increase is twice as high on the female's plot as on to the male's.
- They can talk freely for 5 minutes after they receive all instructions.
- The husband makes the allocation decision. He makes this decision privately after the couple's discussion.
- The husband is informed of potential gains from the base game for himself and for his wife. Women neither observe nor are told about their husband's choice. They are not told how much they can earn from the base game.
- Both will take part in a second-round.

Second-round game

Experimenter Treatment (ET) Same as the base game, the only difference being that now the returns from the female's plot are three times higher than from the male's. Participants are explicitly told that this is the only difference from the previous game. The experimenter reads the instructions and tests understanding. The men make a decision. As in the first-round game, each man knows the potential gains he and his wife may make from Game 2. As in the first-round game, the women do not.

Hidden Treatment (HT) There are two differences with respect to the base game that both members of the couple are informed of:

1. The experimenter tells the husbands that returns on their wife's plot are at least as large as in the first round and that the returns on their own plot are unchanged.
2. The wife, rather than the experimenter, is now in charge of communicating the information on the returns from her plot.

As in the first-round game, each man knows the potential gains he and his wife can make from Game 2. As in the first-round game, the wives do not, nor do they know the decision made by their husband.

Verifiable Treatment (VT) There are three differences from base game that both members of the couple are informed of:

1. The experimenter tells the husbands that returns on their wife's plot are at least as large as in Game 1 and that the returns on their own plot are unchanged.
2. The wife, rather than the experimenter, is now in charge of communicating the information on the returns from her plot.
3. Both male and female participants know that the husbands will be informed by the experimenters of the returns on their wife's plot once they have made their allocation decision.

As in the first-round game, each man knows the potential gains he and his wife can make from Game 2. As in the first-round game, the wives do not, nor do they know the decision made by their husband.

C Empirical Appendix

Table A1: Impact of private information on transfers in relation to first-round transfers made under full information: Robustness results.

First-round transfers	$(BT < 10)$	$(BT < 9)$	$(BT < 8)$	$(BT < 7)$	$(BT < 6)$	$(BT < 5)$
			HT vs (ET+VT)			
HT	-0.1304	-0.6336^a	-0.6536^a	-0.9470**	-0.9368^a	-1.5476**
	(0.3849)	(0.4146)	(0.4269)	(0.4263)	(0.5782)	(0.6983)
N	133	103	91	71	44	32
			HT vs ET			
HT	0.0029	-0.4571	-0.5275	-0.9600^a	-0.7368	-1.6143*
	(0.4893)	(0.5169)	(0.5438)	(0.5688)	(0.7553)	(0.8316)
N	85	64	57	45	31	24
			HT vs VT			
HT	-0.2275	-0.7648*	-0.7463^a	-0.9369**	-1.1215*	-1.4643^a
	(0.4118)	(0.4430)	(0.4558)	(0.4533)	(0.6319)	(0.9023)
N	98	74	66	51	32	22
			VT vs ET			
VT	0.2304	0.3077	0.2188	-0.0231	0.3846	-0.1500
	(0.4420)	(0.4642)	(0.5034)	(0.5732)	(0.8830)	(1.1016)
N	83	68	59	46	25	18

The top line indicates the sample restrictions made based on first-round transfers values. The reported coefficients are for the treatment indicator (HT in the top three panels and VT in the last panel). ET: experimenter treatment (full information), HT: hidden information treatment; VT: ex post verifiable information treatment. Robust standard errors in parentheses. $^a p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$